Title:

METHOD AND DEVICE IN A MULTI-TONE TRANSMISSION SYSTEM

FIELD OF THE INVENTION

The invention relates to a method and a device in a multi-tone transmission system. Discrete MultiTone (DMT) modulation is a method by which the usable frequency range of a channel is separated into a plurality of frequency bands, for instance 256 bands. By dividing the frequency spectrum into multiple channels DMT is thought to perform better in the presence of interference sources such as AM radio transmitters. It is also better able to focus its transmit power on those portions of the spectrum in which it is profitable to send data. DMT forms the basis for Asymmetric Digital Subscriber Line (ADSL) and Very high speed Digital Subscriber Line (VDSL). Therefore, the bandwidth used in a channel is adaptive. Depending on the transmission characteristics a DMT system can use parts of the allowed spectrum.

STATE OF THE ART

For the above described systems presently available receivers use a single wideband analogue-digital converter with high resolution. This results in a high power consumption that is independent of the used bandwidth. In many applications a high power consumption constitutes a major problem. The digital signal is processed in a Digital Signal Processing unit (DSP) which is dimensioned to handle the full bandwidth. A drawback in such a configuration is that unnecessary operations are performed if only a part of the frequency spectrum is used.

SUMMARY OF THE INVENTION

An object of the present invention is to overcome the problems and drawbacks of prior art systems. According to the invention there is provided a plurality of analogue-digital converters for converting separately the analogue signal in each sub band into a digital signal. Each analogue-digital converter is associated to one sub band, and each analogue-digital converter is activated and deactivated in dependence of the presence of a signal in the associated sub band. In accordance with the invention the overall power consumption is decreased and the available bandwidth can be used more efficiently. Power is saved in both the Analogue and the Digital domain.

Further features and advantages of the invention appear in the description below and in the accompanying drawing and dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will in the following be further described in a non-limiting way and with reference to the accompanying drawing. Fig 1, which is a schematic functional block diagram showing one embodiment of a device in accordance with the invention.

DETAILED DESCRIPTION OF THE INVENTION

As shown in the figure a system in accordance with the invention comprises a plurality of band pass filters 10 together forming a filter bank. The transmission spectrum is subdivided into N spectral parts. The band pass filters 10 are connected to a line 12 through which an analogue signal is received. Each of the band pass filters 10 is connected to an analogue-digital converter 11 for converting the analogue DMT signal into a digital signal. The spectrum of each part n can be sampled at a base band rate due to

the band pass character of the spectrum received by each A/D converter.

The bands are intimately connected to the FFT (fast Fourier transform) algorithm which DMT uses as its modulator and demodulator. The FFT is used to separate the frequencies into individual bands and it generates spectra, which are fully separable on the receiving end. Instead of FFT the discrete wavelet transform may be used. Normally, the discrete wavelet transform will do a better job of isolating the individual frequency spectra.

The assignment of channels is left flexible, but e.g. ADSL uses channels 6-31 for upstream (24KHz-136KHz), 32-250 for downstream (136KHz-1.1MHz). The modulation used on any given frequency channel is QAM. Channels 16 and 64 are reserved for pilot tones which are used to recover timing. The number of bits per symbol within each channel may be independently selected allowing the modem to be rate adaptive. Other systems, e.g. VDSL will use other settings.

A control unit 13 individually controls each analogue-digital converter 11. The control unit may switch the converters 11 on and off and also perform other control tasks such as assigning other lines or channels to the converters.

The digital signals from each of the analogue-digital converters 11 are supplied to entities 15 of a signal processing unit 14. These entities can be physical blocks or logical functions in a DSP and are dedicated for a separate part of the available bandwidth. While the input to each A/D converter is band pass filtered only the information for the tones in the passband will be present in the A/D converted signal. The signal processing unit

14 performs the appropriate digital filtering, transformation and detection of the tones in each part of the band.

As the filterbank divides the analogue signal into N bands each subband will be independent of the other bands after the filter bank. If the bandwidth for subband $n>x$, $n<=N$ is not used for transmission the A/D converters and corresponding signal processing entities 15 for $n>x$ will be switched off by the control unit 13.

In a multi receiver implementation a processor pool can be envisioned as a practical embodiment and each receiver path would be allocated the required processing capabilities from the pool. This could be both physical processing blocks such as FFT kernels or capacity in a generic DSP. In this way it is possible to avoid the allocation of resources that are not needed, and parts of the processor pool can be powered down or be used to accommodate more channels or more demanding coding schemes.

The control unit 13 will control the A/D converters and/or the entities 15 of the signal processing unit 14 in dependence of how the spectrum is used. The use of the spectrum can be determined by the signal processing unit 14 which continuously can monitor the complete spectrum. Information indicative of the use of the spectrum is transferred to the control unit through a first control line 16. It is possible also to determine the use of the spectrum manually and to transfer control information from a manually operated means 17, such as a computer, through a second control line 18. A third control line 19 is used by the control unit 13 to inform the signal processing unit 14 about the allocated capacity.

In a practical embodiment an analogue front-end may comprise ten A/D converters and ten band pass filters in a central office side. This side is capable of handling one VDSL channel. The signal processing unit 14 can be a common pool of DSP:s that serves a lot of channels.

By connecting an ADSL modem at the consumer side only about one tenth of the available bandwidth is used. As a result most of the A/D converters can be turned of by the control unit 13 and the excess signal processing power can be used for more lines and to handle the more demanding coding used in ADSL. If more channels are to be used more analogue front ends are required.

The described system is very well suited for multi tone based copper access modems especially using DMT. It is however applicable in all multi tone based transmission systems. Other suitable applications lay in systems where power consumption is a critical factor and the used transmission bandwidth can be varied. Systems based on DMT or Wavelettransform with dynamic bandwidth allocation as a result of different bitcapacity demands and channel characteristics is especially suitable for these methods.